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Pitchford

[11] **4,310,320**

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[54] **ELECTRICAL CONTROL FOR TRIM/TILT OF DUAL OUTBOARD OR STERN DRIVES**

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[52] **U.S. Cl.** **440/61;** 440/79

[58] **Field of Search** 440/53, 61, 1, 2, 80, 440/62, 63, 900, 79

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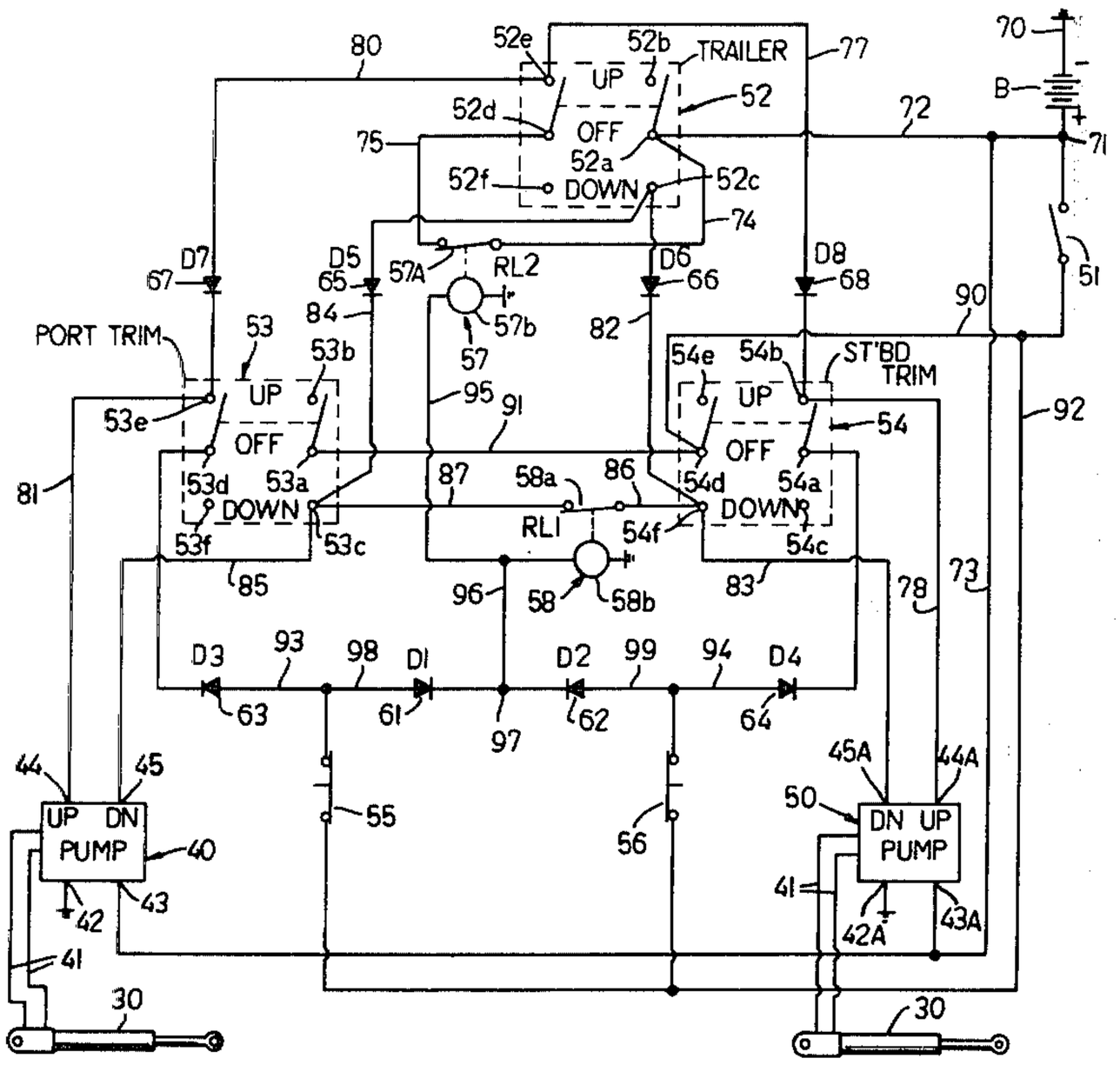
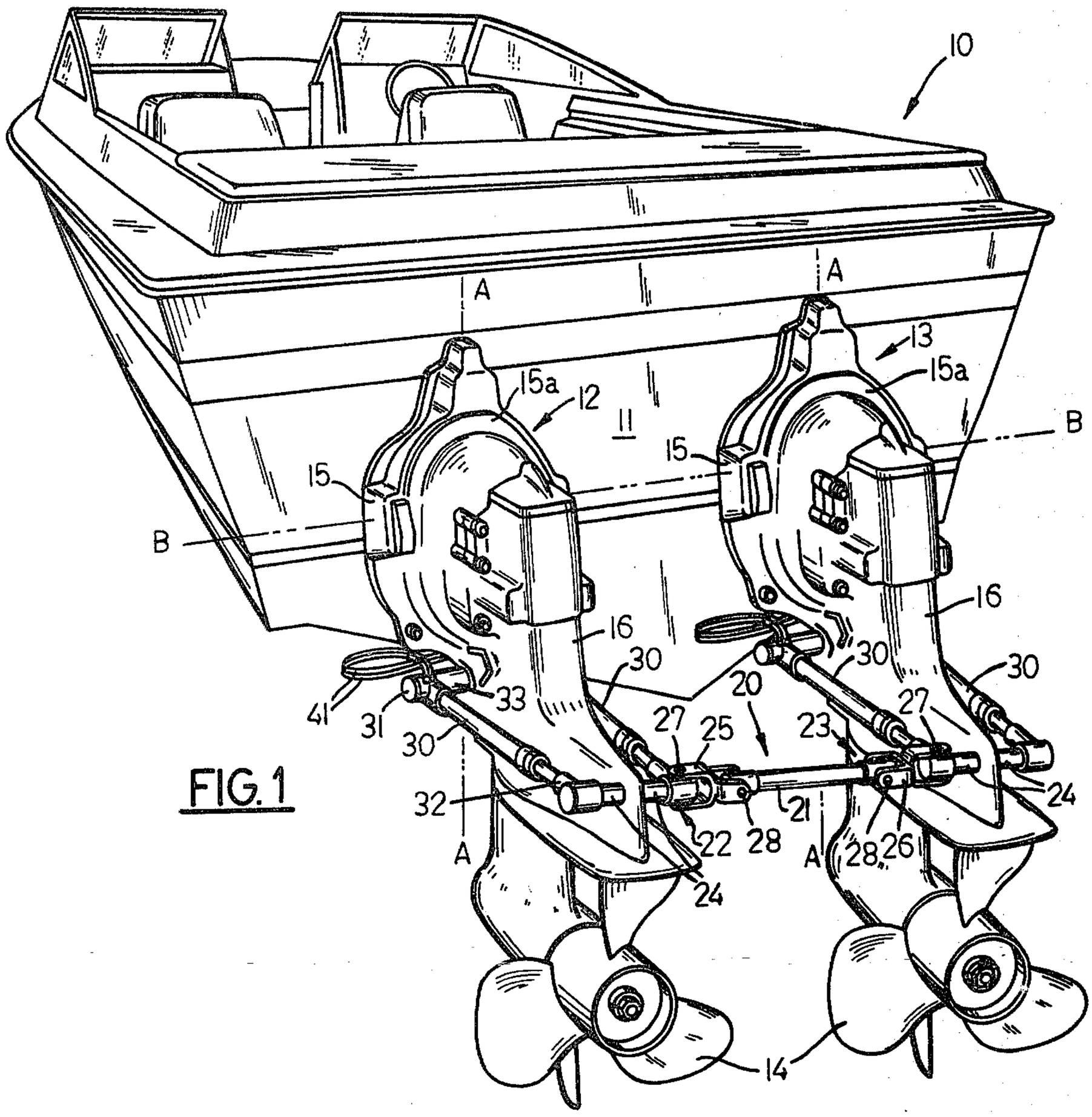
Primary Examiner—Trygve M. Blix
Assistant Examiner—John C. Paul

[57] **ABSTRACT**

An electrical control system for a pair of stern drives (or outboard motors) mounted side-by-side on a boat transom and mechanically linked to tilt them within a trim range to improve operational performance or to tilt them above the trim range to facilitate shallow water navigation, launching or trailing, comprises: a key-operated main switch; three manually operable toggle type (off, up, down) selector switches, namely, a trailer switch, a starboard trim switch, and a port trim switch; and other circuit components. With the main switch off (as when launching or trailing), trailer switch "up" or "down" effects corresponding tilt of both drives simultaneously to a desired position regardless of their initial position and the trim switches are ineffective. With the main switch on (as during boat operation), trailer switch "down" effects down tilt of both drives simultaneously to a desired position regardless of initial position, whereas trailer switch "up" effects up tilt of both drives only if both drives are already above the trim range. If both drives are above the trim range, operation of either trim switch "down" moves both drives simultaneously down, until the trim range is reached; but operation of either trim switch "up" has no effect. If both drives are within the trim range, either trim switch "up" or "down" effects corresponding tilt of the respective drive, but only within the trim range.

11 Claims, 5 Drawing Figures

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A
A
13
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12
11
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15
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B
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30
30
30
20
33
41
31
27
25
27
23
30
24
32
22
28
21
28
26
A
A
24
14

FIG. 1

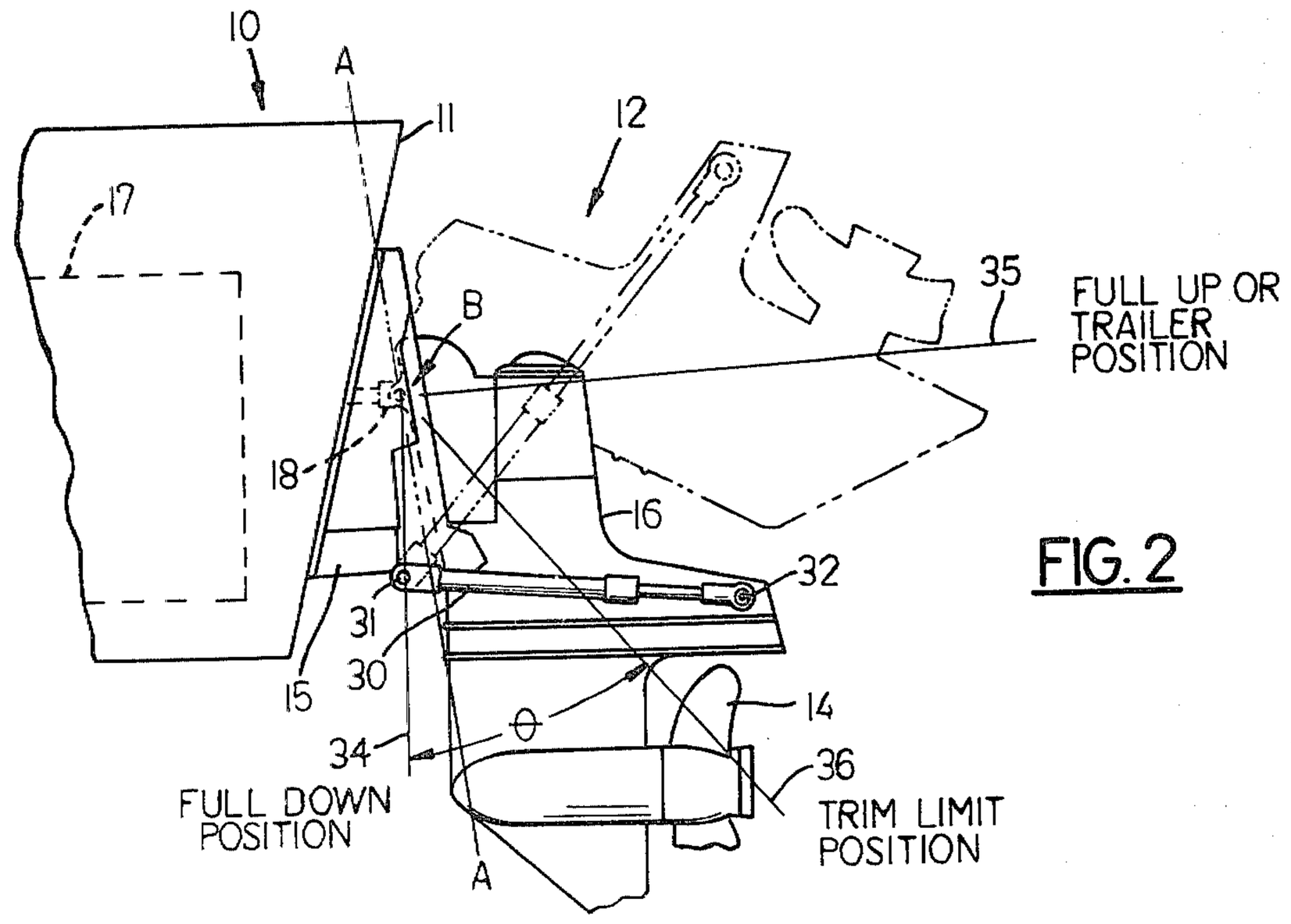
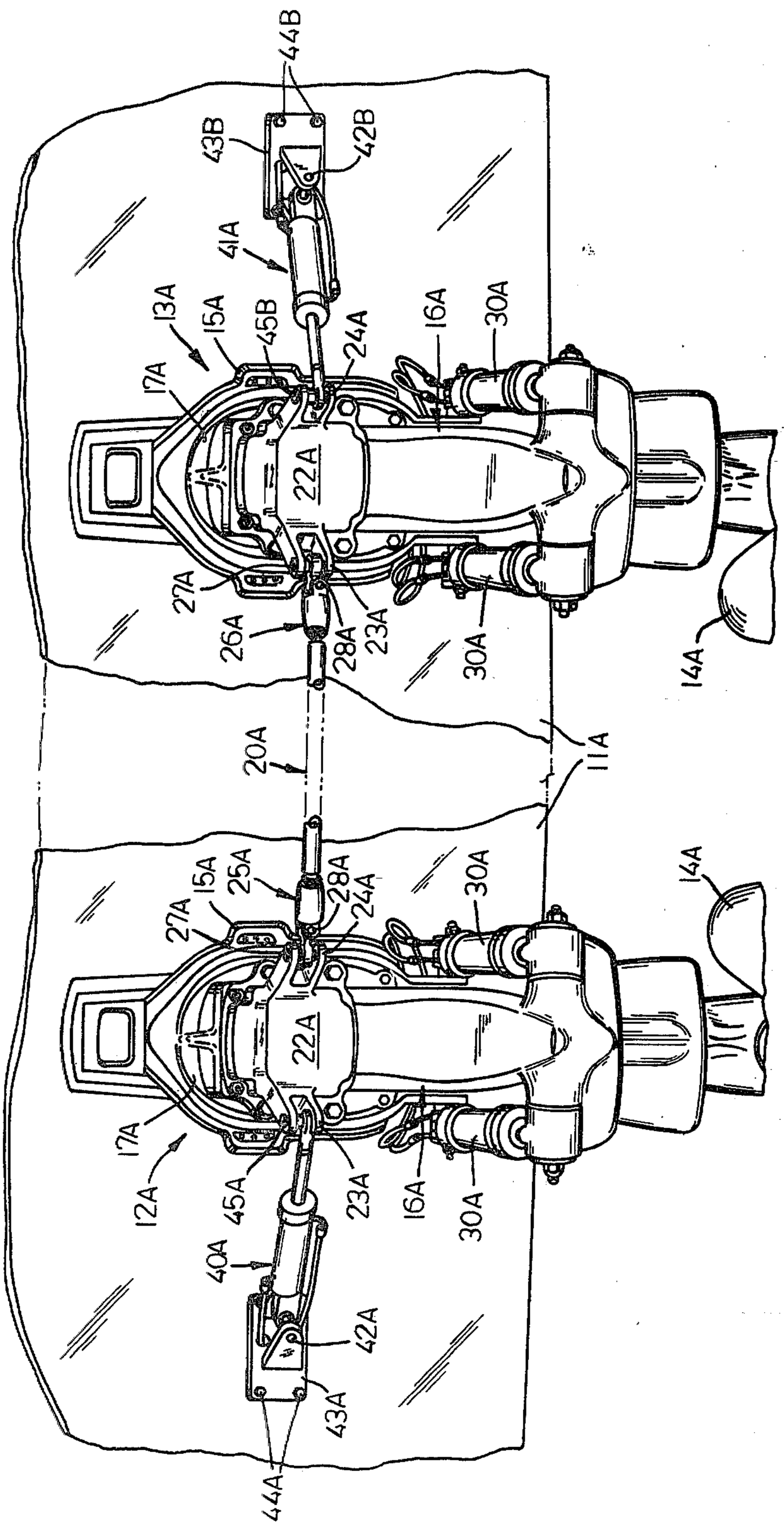

10
A
11
12
17
35
FULL UP OR
TRAILER
POSITION
B
18
16
32
31
30
15
14
θ
34
36
FULL DOWN
POSITION
TRIM LIMIT
POSITION
A

FIG. 2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43B
42B
41A
13A
15A
45B
24A
16A
30A
17A
22A
27A
26A
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23A
30A
14A
11A
20A
15A
25A
27A
28A
24A
30A
14A
22A
17A
12A
45A
23A
16A
30A
40A
42A
43A
44A

FIG. 3

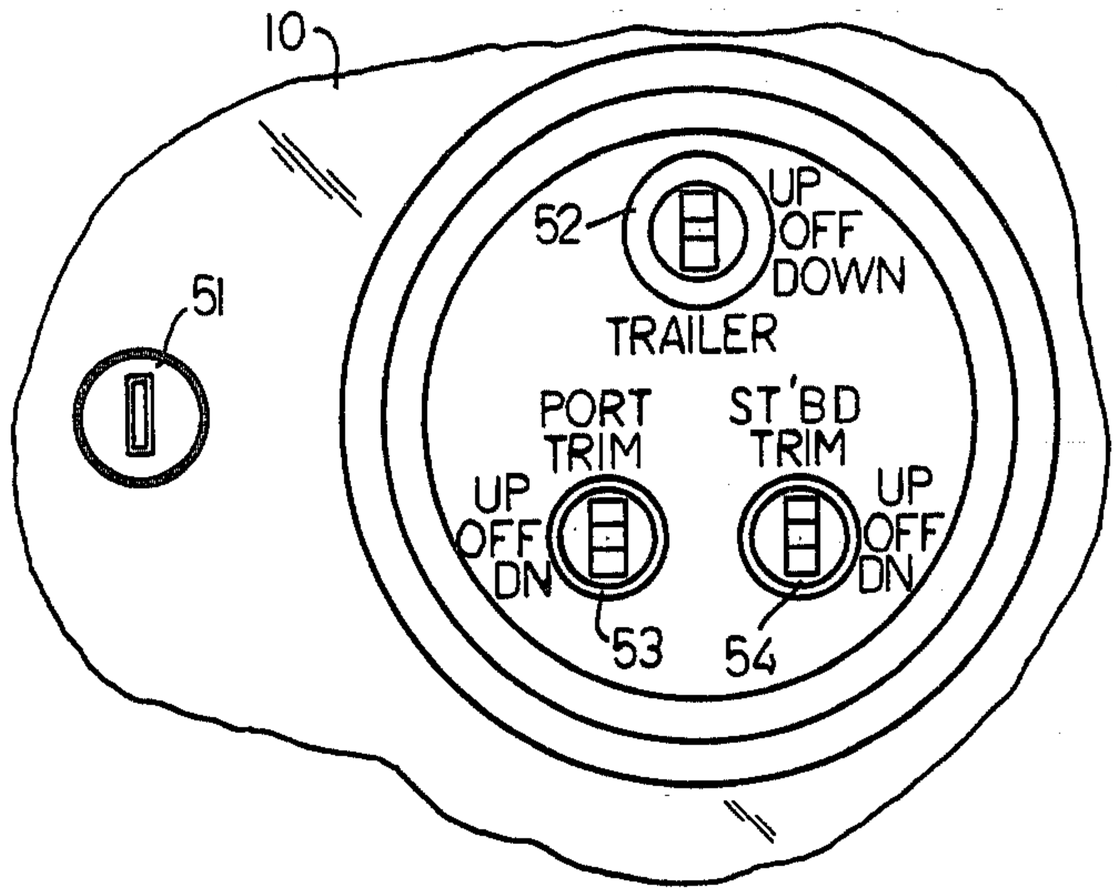
10
51
52
UP
OFF
DOWN
TRAILER
PORT TRIM
ST'BD TRIM
UP
OFF
DN
53
54

FIG. 4

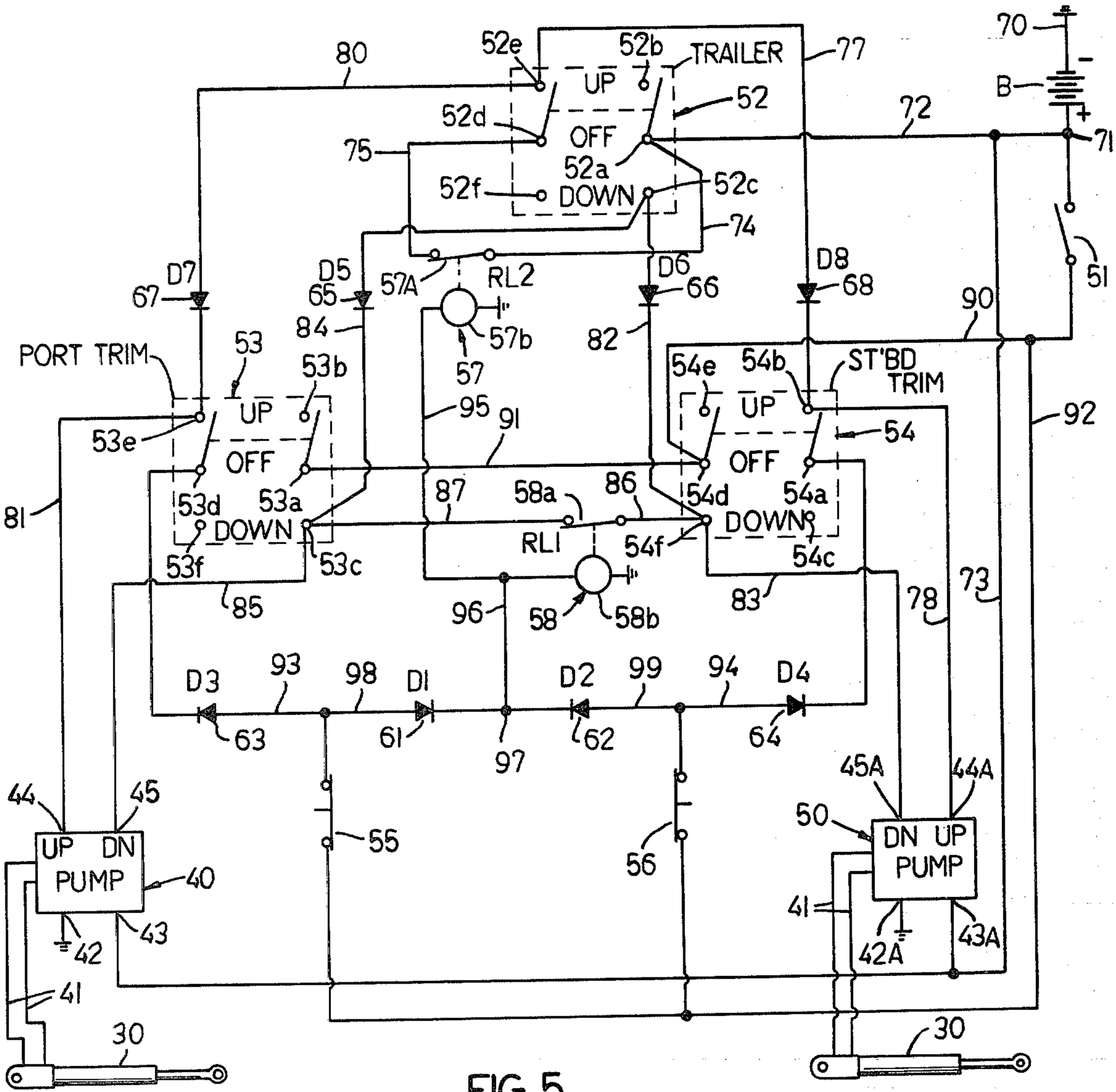
80
52e
52b
TRAILER
77
70
UP
52
B
52d
OFF
72
75
52a
71
52f
DOWN
52c
74
D7
D5
57A
RL2
D6
D8
67
65
66
68
51
84
57b
82
90
PORT TRIM
53
53b
57
54e
54b
ST'BD TRIM
95
91
92
53e
UP
54
OFF
OFF
81
53d
53a
87
58a
86
54d
54a
DOWN
DOWN
RL1
54f
54c
53f
53c
85
96
58
58b
83
78
73
D3
93
98
D1
D2
99
94
D4
63
61
97
62
64
45A
44A
44
45
55
56
50
UP DN
PUMP
DN UP
PUMP
40
41
42
43
42A
43A
30
30

FIG. 5

ELECTRICAL CONTROL FOR TRIM/TILT OF DUAL OUTBOARD OR STERN DRIVES

TECHNICAL FIELD

This invention relates generally to electrical control systems for trimming and tilting dual-mounted outboard motors or stern drives.

BACKGROUND ART

U.S. Pat. Nos. 3,434,449 and 3,641,965, owned by the same assignee as the present application, disclose electrically controlled switch actuated hydraulically powered extendable and retractable trim/tilt cylinders for vertically trimming or tilting individual outboard motors or stern drives to desired angular positions. Such a cylinder, which is supplied with hydraulic operating fluid from a motor driven pump and responds to actuation of a manually operable three position (off, up, down) electrical switch, effects trim positioning of the drive, as during boat operation, and also raises and lowers the drive for clearance purposes. Trimming is carried out within a trim angle or trim range (defined by full down drive position and some higher trim limit position) and changes the angle of propeller thrust thereby causing the boat bow to raise or lower and enables selection of a proper and more efficient angle for different loads or different water conditions or for getting on plane. Tilting or raising the drive up past the trim range for clearance purposes enables safer shallow water running and facilitates launching or trailing.

When two such trimmable/tiltable drives are mounted side-by-side and used to power the same boat, the power pulses from one drive's propeller interact with the other drive and can cause increased wear of drive components and other problems. The effect of this phenomena is diminished by using an external "tie bar" that mechanically and pivotably connects the housings of the two drives together outside of the boat, while at the same time permitting the drives to be moved horizontally for steering purposes by suitable steering means inside or outside of the boat transom. However, since the tie bar does not telescope or change length in any way, damage can be incurred if the aforedescribed trim/tilt cylinders are operated independently to move one drive up or down for a substantial distance while the other drive is still relatively stationary. Nevertheless, because of mechanical tolerances and clearances in the connection of the tie bar to the drives, relatively small differences in drive angle between the adjacent drives are still possible for trim purposes and do not result in damage. Accordingly, anyone operating a dual drive boat with such an external tie bar has to use extreme care to avoid damage to the drives and/or the tie bar when actuating the trim/tilt cylinders for any purpose.

DISCLOSURE OF INVENTION

The present invention provides an improved electrical control system for effecting trim/tilt positioning of a pair of outboard motor drives or stern drives (each type hereinafter called "drives") which are mounted side-by-side on a boat transom, and especially drives which are mechanically interconnected by an external tie rod. The control system presupposes that each drive, which is horizontally pivotably for steering by suitable steering means inside or outside of the boat transom, is also pivotable or tiltable by suitable electrically controllable

means about an axis in a generally vertical plane to positions between a full down position and a full up (or "trailer") position and to any position therebetween and that there is a trim angle or trim range between full down position and some trim limit position thereabove.

The electrical control system comprises a main switch, three manually operable toggle type (off, up, down) selector switches (designated trailer, starboard trim, port trim), a pair of trim position limit switches (port and starboard) responsive to the position of their respective drives, a pair of relays, and a plurality of diodes for isolation of the port and starboard circuit functions, as well as to prevent erratic system operation when more than one selector switch is operated at the same time.

With the main switch off (open), the relay coils remain de-energized and their contacts closed because the limit switches, whether open or closed, have no effect on circuit operation and certain diodes prevent energization of the relay coils even if the trailer switch and either or both of the trim switches are actuated simultaneously. Therefore, trailer switch "up" or "down" effects corresponding tilt of both drives simultaneously regardless of their initial position.

With the main switch on (closed), the relays and limit switches become operative. As before, trailer switch "down" effects down tilt of both drives simultaneously regardless of initial position. However, trailer switch "up" effects up tilt of both drives only if both drives are already above the trim range and the limit switches are both open, thereby causing the relay coils to be de-energized and their contacts to be closed. If both drives are above the trim range, either trim switch "down" effects down tilt of both drives simultaneously, until the trim range is reached, whereupon the limit switches close to energize the relays and open the relay contacts. Opening the contacts of one relay isolates the port and starboard control portion of the control circuit. If both drives are within the trim range, either trim switch "up" or "down" effects corresponding tilt only of its respective drive because one relay opens resulting in individual drive control.

The control system is well-adapted for use with drives having electrically controlled hydraulically powered trim/tilt cylinders which are supplied with operating fluid by electric motor driven hydraulic pumps. However, the control system could be employed with other types of electrically controllable devices for effecting trim/tilt positioning of the drives.

An electrical control system in accordance with the present invention offers numerous advantages over the prior art. For example, independent trimming of one drive relative to the other within a small trim range is possible so as to obtain maximum performance efficiency. However, wide angle tilt changes between the two drives is automatically prevented regardless of possible operator misuse of the manually operable selector switches. Furthermore, the number of manually operable switches required to achieve a wide variety of drive positions for dual drive arrangements is reduced, as compared to prior art arrangements, thereby simplifying switch operations. The effect of the main key-operated switch on operation of the three selector switches provides further versatility and safety. Other objects and advantages will hereinafter appear.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a perspective view of the stern of a boat having two mechanically interconnected tiltable propulsion units or drives, such as stern drives, mounted on the exterior of the boat transom.

FIG. **2** is a side elevational view of the boat stern and port drive of FIG. **1**, showing the drive in full down position and also showing it, in phantom lines, tilted to full up or trailer position.

FIG. **3** is an end elevational view of the stern of a boat having two mechanically interconnected tiltable stern drives with externally mounted power steering cylinders.

FIG. **4** is a front elevational view of a switch panel mounted on the boat operator's control console and containing three manually operable selector switches.

FIG. **5** is an electrical circuit diagram of an electrical control system in accordance with the present invention for tilting the drives of FIGS. **1**, **2** and **3** by means of the switches of FIG. **4**.

BEST MODE FOR CARRYING OUT THE INVENTION

FIGS. **1** and **2** show a boat **10** having a transom **11** on which a pair of stern drives **12** and **13** are dual-mounted in adjacent side-by-side spaced-apart relationship for propelling the boat. The port and starboard stern drives **12** and **13**, respectively, which could take the form of outboard motors, are similar to each other in construction, mode of operation and certain associated components, and, therefore, only port drive **12** is hereinafter described in detail.

Stern drive **12**, which includes a drive unit **16** connected to the transom **11** through a transom bracket **15**, includes a gimbal ring **15***a* which pivotally supports the drive unit **16** about a vertical axis A—A for steering and about a horizontal axis B—B for trimming. The drive unit **16** includes a propeller **14** which is driven by an engine **17** inside boat **10** by means of a suitable drive train (not shown) which extends through transom bracket **15** and through drive unit **16**. A flexible coupling or a universal joint **18** (see FIG. **2**) permits the drive unit **16** to move during steering and trimming.

It is to be understood that drive **12** is pivotable to port and starboard about axis A—A for steering purposes by means of a steering linkage (not shown). Drive **12** is also pivotable or tiltable in a vertical direction about axis B—B for trim and tilt purposes, as shown in FIG. **2** and hereinafter explained.

As FIG. **1** shows, the drives **12** and **13** are mechanically interconnected by mechanical means, such as a tie-rod assembly or linkage **20**, located exteriorly of transom **11** which serves to overcome or diminish the effects caused by power pulses from the propeller of one drive on the other drive in dual drive systems such as herein disclosed, while at the same time allowing the drives to be steered, trimmed and tilted vertically. Tie-rod assembly **20** comprises a tubular rigid fixed length non-telescopic tie-rod **21** which is universally connected by connecting means **22** and **23** at opposite ends to a projection **24** on drives **12** and **13**. Connecting means **22** and **23** include a universal coupling **25** and **26** which permits vertical relative movement between the drives through pins **27** and **28**. The universal couplings **25** and **26** enable the drives **12** and **13** to assume different trim positions within a trim limit range.

As FIGS. **1** and **2** show, drive **12** is tiltable vertically by means of a pair of hydraulically operated extendable and retractable trim/tilt cylinders, such as **30**, which may take the form of those cylinders disclosed in aforementioned U.S. Pat. Nos. 3,434,449 and 3,541,965. Cylinder **30** has its opposite ends pivotally connected by pivot means **31** and **32** to projections **33** and **24**, respectively, on stationary mount **15** and housing **16**, respectively, of drive **12**. When the cylinders **30** are fully retracted, drive **12** assumes the full down position shown in FIGS. **1** and **2** and designated by the full down position line **34** in FIG. **2**. When the cylinders **30** are fully extended, drive **12** assumes the full up or "trailer" position shown in phantom lines in FIG. **2** and designated by the full up position line **35** in FIG. **2**. The cylinders **30** are operable to tilt or pivot drive **12** to full down or full up position or to any position therebetween, including trim positions within a trim angle or trim range θ between full down line **34** and a trim limit position line designated **36** in FIG. **2**. The trim angle θ is the range within which drive **12** is typically positioned to effect trimming while boat **10** is running and the trim limit position line **36** is determined by the location, positioning or setting of a trim limit switch **55** for drive **12**, as hereinafter described and shown in FIG. **5**.

It is to be understood that drive **13**, which as FIGS. **1** and **4** show is provided with trim/tilt cylinders **30**, is also positionable in the same manner as drive **12**.

The pair of trim/tilt cylinders **30** for port drive **12** are operated by an electro-hydraulic actuator system **40**, shown schematically in FIG. **5**, the specifics of which are not part of the present invention, except as follows: Actuator system **40** is connected by a pair of hydraulic fluid supply/return lines **41** to each cylinder **30** of drive **12** and is provided with four external electrical connection terminals designated ground terminal **42** connected to ground, main supply terminal **43**, up terminal **44** and down terminal **45**. Actuator system **40** may take the form of that disclosed in aforementioned U.S. Pat. No. 3,434,449 and is understood to comprise a hydraulic pump, a reversible electric motor for the pump, and other operating components, none of which are shown specifically in the drawings of the present specification. It is sufficient for purposes of the present specification to understand that actuator system **40** and its associated trim/tilt cylinder **30** for port drive **12** operate as follows: When terminals **42**, **43**, **44** and **45** are connected as shown in FIG. **5**, energization of up terminal **44** effects extension of the trim/tilt cylinders **30** for drive **12** and upward tilting of drive **12** for as long as the terminal **44** is energized, whereas energization of down terminal **45** effects retraction of the trim/tilt cylinder **30** for drive **12** and downward tilting of drive **12** for as long as the terminal **45** is energized.

As FIG. **5** shown, the trim/tilt cylinders **30** of drive **13** are provided with an electro-hydraulic actuator system **50** which is similar in all respects to system **40** as hereinbefore described and has terminals designated **42A**, **43A**, **44A** and **45A** corresponding to the terminals **42**, **43**, **44** and **45**, respectively, of actuator system **40**.

FIG. **3** shows another embodiment of a pair of stern drives, designated **12A** and **13A**, which are dual mounted side-by-side on a boat transom **11A** and interconnected by mechanical means, such as a tie-rod assembly or linkage **20A**. Unlike the drives **12** and **13** hereinbefore described which are each pivoted about a vertical axis A—A for steering purposes by steering means located inside the boat, the drives **12A** and **13A**

are pivoted about a vertical axis for steering purposes by a pair of power steering cylinders **40A** and **41A** which are located externally of boat transom **11A** which are mechanically connected to the drive. However, it is to be understood that the drives **12A** and **13A** are pivotable horizontally and vertically in the same manner as the drives **12** and **13** and that the electrical control system shown in FIG. **5** and hereinbefore described is usable with the drives **12A** and **13A**, as well as the drives **12** and **13**. Accordingly, the electrical control system is hereafter described specifically in connection with the drives **12** and **13**.

As FIG. **3** shows, drives **12A** and **13A** are similar in construction and, therefore, only drive **12A** is hereinafter described in detail. Drive **12A** includes a drive unit **16A** which is connected to transom **11A** through a transom bracket **15A**. Drive unit **16A** includes a gimbal ring **17A** which pivotably supports the drive unit for movement about a vertical axis for steering purposes and for movement about a horizontal axis for trimming. Drive unit **16A** includes a propeller **14A** and a suitable drive trim (not shown). Drive unit **16A** is pivotable vertically by means of a pair of trim/tilt cylinders **30A**, similar to cylinder **30** hereinbefore described.

Drive unit **16A** is provided with a back cover bracket **22A** which has a pair of rearwardly extending projections **23A** and **24A**. The tie-rod assembly **20A** extends between and is universally connected by connecting means **25A** and **26A** to the projections **24A** of stern drive **12A** and to the projections **23A** of stern drive **13A**, respectively. Each connecting means **25A**, **26A** is understood to comprise a universal coupling which permits vertical relative movement between the drives through the pins **27A** and **28A**.

The power steering cylinder **40A** has its cylinder end pivotably connected by a horizontally disposed bolt or pin **42A** to a transom mounting bracket **43A** which is rigidly secured to transom **11A** by bolts **44A** outboard of the stern drive **12A**. The rod end of power steering cylinder **40A** is pivotably connected by a vertically disposed bolt or pin **45A** to the projection **23A** of stern drive **12A**. The power steering cylinder **41A** has its cylinder end pivotably connected by a horizontally disposed bolt or pin **42B** to a transom mounting bracket **43B** which is rigidly secured to transom **11A** by bolts **44B** outboard of the stern drive **13A**. The rod end of power steering cylinder **41A** is pivotably connected by a vertically disposed bolt or pin **45B** to the projections **24A** of stern drive **13A**.

Each steering cylinder **40A**, **41A** is of the double-acting type and, during a steering operation, one extends while the other retards, to apply steering force directly to the interconnected stern drives **12A** and **13A**. The horizontal and vertical disposition of the bolts **42A**, **42B** and **45A**, **45B**, respectively, permit the drive units of the stern drives **12A** and **13A** to pivot vertically in response to operation of the appropriate tilt cylinder **30A**, as does the construction and arrangement of tie-bar assembly **20A**.

The tie-bar assembly **20A** and the steering cylinders **40A**, **41A** are mechanical means which, when connected to the drives as shown, permit independent vertical movement of the drive units **16A** of the stern drives **12A** and **13A** at least within the trim range but prevent full independent vertical movement of the drive units relative to each other in either the trim range or the tilt range. The same holds true for the tie-bar assembly **20** of FIG. **1**.

FIG. **5** shows an electrical control system in accordance with the invention for operating the electrohydraulic systems **40** and **50** for the drives **12** and **13**, respectively. The control system is supplied from a storage battery B and comprises a main switch **51**, three manually operable selector devices, such as electric switches (designated trailer switch **52**, starboard trim switch **54**, port trim switch **53**), a pair of trim position limit switches (port switch **55** and starboard switch **56**) which are understood to be mounted or located so as to be responsive to drive position, a pair of relays **57** and **58**, and a plurality of circuit isolation diodes **61** through **68**. The main switch **51** is preferably a key-operated single pole single throw switch associated with an ignition switch (not shown) for the boat. Each selector switch **52**, **53**, **54** as shown in FIGS. **4** and **5**, is preferably a double pole double throw momentary switch having an off, up, and down position. The limit switches **55** and **56** are single pole single throw switches which are closed when their respective drives **12** or **13** are below the trim limit position, i.e., within the trim range θ, and which are open when the drives are above the trim limit position line **36**. The relays **57** and **58** are single pole single throw normally closed relays. The diodes **61** through **68** are used for isolation of the port and starboard circuit functions, as well as to prevent erratic system operation when more than one selector switch **52**, **53**, **54** is operated at the same time.

Negative terminal **70** of battery B is grounded. Positive terminal **71** of battery B is connected by a conductor **72** to movable contact **52***a* of trailer switch **52**. Positive terminal **71** of battery B is alos connected by a conductor **73** to the main terminals **43** and **43A** of the actuator systems **40** and **50**, respectively. Movable contact **52***a* of trailer switch **52** is connected by a conductor **74** to one side of normally closed relay contact **57***a* of relay **57** and the other side of relay contact **57***a* is connected by a conductor **75** to movable contact **52***d* of trailer switch **52**.

Stationary up contact **52***e* of trailer switch **52** is connected by a conductor **77**, which has diode **68** in series therein, to stationary up terminal **54***b* of starboard trim switch **54** and the latter terminal **54***b* is connected by a conductor **78** to up terminal **44A** of actuator system **50**. Stationary up contact **52***e* of trailer switch **52** is also connected by a conductor **80**, which has diode **67** in series therein, to stationary up terminal **53***e* of port trim switch **53** and the latter terminal **53***e* is connected by a conductor **81** to up terminal **44** of actuator system **40**.

Stationary down contact **52***c* of trailer switch **52** is connected by a conductor **82**, which has diode **66** in series therein, to stationary down terminal **54***f* of starboard trim switch **54** and the latter terminal **54***f* is connected by a conductor **83** to down terminal **45A** of actuator system **50**. Stationary down contact **52***c* of trailer switch **52** is also connected by a conductor **84**, which has diode **65** in series therein, to stationary down terminal **53***c* of port trim switch **53** and the latter terminal **53***c* is connected by a conductor **85** to down terminal **45** of actuator system **40**.

Stationary down terminal **54***f* of starboard trim switch **54** is connected by a conductor **86** to one side of normally closed relay contact **58***a* of relay **58** and the other side of relay contact **58***a* is connected by a conductor **87** to stationary down terminal **53***c* of port trim switch **53**.

Positive terminal **71** of battery B is connected to one side of main switch **51** and the other side of main switch

51 is connected by a conductor **90** to the movable contact **54***d* of starboard trim switch **54** and movable contact **54***d* is connected by a conductor **91** to the movable contact **53***a* of port trim switch **53**.

The said other side of main switch **51** is also connected by a conductor **92** to one side of the trim limit switches **55** and **56**.

The other side of port trim limit switch **55** is connected by a conductor **93**, which has diode **63** in series therein, to movable contact **53***d* of port trim switch **53**.

The other side of starboard trim limit switch **56** is connected by a conductor **94**, which has diode **64** in series therein, to movable contact **54***a* of starboard trim limit switch **54**.

The relay coils **57***b* and **58***b* of the relays **57** and **58**, respectively, each have one side connected to ground. The other sides of the relay coil **57***b* and **58***b* are connected to each other by a conductor **95** and the latter is connected by a conductor **96** to a point **97**.

The said other sides of the trim limit switches **55** and **56** are also connected by conductors **98** and **99**, respectively, to point **97**. The conductors **98** and **99** have the diodes **61** and **62**, respectively, connected in series therein and the diodes **61** and **62** are oppositely poled relative to each other.

Referring to FIGS. **4** and **5**, the switches operate as follows. With the main switch **51** off (as when launching or trailing), trailer switch **52** "up" or "down" effects corresponding tilt of both drives **12** and **13** simultaneously to a desired position regardless of their initial position and the trim switches **53** and **54** are ineffective. With the main switch **51** on (as during boat operation), trailer switch **52** "down" effects down tilt of both drives **12** and **13** simultaneously to a desired position regardless of initial position, whereas trailer switch **52** "up" effects up tilt of both drives only if both drives are already above the trim range θ. If both drives **12** and **13** are above the trim range θ, either trim switch **53** or **54** "down" effects down tilt of both drives simultaneously, until the trim range θ is reached, but either trim switch **53** or **54** "up" has no effect. If both drives **12** and **13** are within the trim range θ, either trim switch **53** or **54** "up" or "down" effects corresponding trim of the respective drive, but only within the trim range θ.

The circuit shown in FIG. **5** operates generally as follows. With the main switch **51** off (open), the relays **57** and **58** remain de-energized and closed and the limit switches **55** and **56** have no effect on circuit operation. Therefore, trailer switch **52** "up" or "down" effects corresponding tilt of both drives **12** and **13** simultaneously regardless of their initial position. The trim switches **53** and **54** are totally ineffective because switch **51** is open and because of the operation of diodes **63** and **64**.

With the main switch **51** on (closed), the relays **57**, **58** and limit switches **55**, **56** become operative. As before, trailer switch **52** "down" effects downtilt of both drives **12** and **13** simultaneously regardless of initial position. However, trailer switch **52** "up" effects up tilt of both drives only if both drives are already above the trim range θ and the limit switches are both open, thereby causing the relay coils to be de-energized and their contacts to be closed. If both drives **12** and **13** are above the trim range θ, either trim switch **53** or **54** "down" effects down tilt of both drives simultaneously, until the trim range θ is reached, whereupon the limit switches close to energize the relays and open the relay contacts. Opening the contacts of one relay **58** isolates the port and starboard control portion of the control circuit. If both drives **12** and **13** are within the trim range θ, either trim switch **53** or **54** "up" or "down" effects corresponding tilt only of the respective drive it controls. This occurs because relay **57** allows trailering up only when both drives have been raised and have reached their respective trim limit thereby opening the limit switches **55** and **56** and causing the relays **57** and **58** to be de-energized. The relay **58** allows both drives **12** and **13** to move down when either the port or starboard trim switches **53** or **54** are operated and the drives are above the trim limit range θ. At the point that either drive **12** or **13** moving down reaches its trim limit and a trim limit switch **55** or **56** closes, the other relay **58** opens resulting in individual drive control.

The circuit shown in FIG. **5** operates more specifically as follows.

Operation With Main Switch Open

Assume initially that main switch **51** is open and that the selector switches **52**, **53** and **54** are off (open). In this situation, the relay coils **57***b* and **58***b* are de-energized and their contacts **57***a* and **58***a*, respectively, are closed. Furthermore, the up terminals **44**, **44A** and the down terminals **45**, **45A** of the actuators **40** and **50**, respectively, are de-energized, although the main terminals **43** and **43A** of the actuators **40** and **50**, respectively, are already energized from battery terminal **71** through conductor **73**. Accordingly, the trim/tilt cylinders **30** for the drives **12** and **13**, as well as the drives themselves, remain stationary in whatever position they are in. The condition of the limit switches **55** and **56** has no effect on circuit operation and, therefore, it is of no consequence whether the drives are within or above the trim range θ.

Now assume that main switch **51** remains open (off) but that trailer switch **52** is actuated. If actuated up, an electrical circuit is established from battery terminal **71**, through conductors **72**, **74** (relay contact **57***a* is closed), **75** and through movable contact **52***d* to stationary up terminal **52***e* of trailer switch **52**. Circuits are also established from terminal **52***e* through conductors **77**, **78** to up terminal **44A** of actuator **50** and from terminal **52***e* through conductors **80**, **81** to up terminal **44** of actuator **40**. Therefore, the actuators **40** and **50** effect extension of the cylinders **30** for the drives **12** and **13**, respectively, causing the latter to pivot upward simultaneously for as long as trailer switch **52** is actuated up. If either trim switch **53** or **54** were actuated up while trailer switch **52** is up, the diodes **63** or **64**, respectively, would prevent energization of the relays **57** and **58**, respectively.

On the other hand, if switch **52** is actuated down, while main switch **51** is open (off), an electrical circuit is established from battery terminal **71** and through conductor **72** and through movable contact **52***a* to stationary down terminal **52***c* of trailer switch **52**. Circuits are also established from terminal **52***c* through conductors **84**, **85** to down terminal **45** of actuator **40** and from terminal **52***c* through conductors **82**, **83** to down terminal **45A** of actuator **50**. Therefore, actuators **40** and **50** effect retraction of the cylinders **30** for the drives **12** and **13**, respectively, causing the latter to pivot downward simultaneously for as long as trailer switch **52** is actuated down. Simultaneous actuation of either trim switch **53** or **54** in either direction while trailer switch **52** is down has no effect.

As is apparent, if main switch **51** is open (off), and trailer switch **52** is off, neither trim switch **53** or **54** can effect system operation regardless of which position it is placed in.

Operation With Main Switch Closed

Now assume that main switch **51** is closed (on) and that, initially, the selector switches **52, 53, 54** are off. As will be understood, in this situation the following conductors are always energized: conductors **72** and **74**, conductors **90** and **91**, conductor **73**, conductor **92**. Furthermore, the following contacts are always energized: the movable contacts **53***a* and **54***d* of the port and starboard trim switches **53** and **54**, respectively; and movable contact **52***a* of trailer switch **52**. Under these circumstances, the initial position of the drives **12** and **13** and, therefore, the condition of the limit switches **55** and **56** actuated thereby, determine the effect of actuation of the selector switches **52, 53, 54**.

Drives Above Trim Limit

When main switch **51** is closed and both drives are above the trim limit position (i.e., above line **36** in FIG. **2**), then both limit switches **55** and **56** are open and both relays **57** and **58** are off. In this situation actuation of trailer switch **52** up causes energization of both up terminals **44** and **44**A of the actuator system **40** and **50**, respectively, to raise both drives **12** and **13** simultaneously. This occurs because a circuit is established through closed relay contact **57***a* and conductor **75** to terminal **52***d* and up terminal **52***e* of trailer switch **52**. Circuits are also established through conductors **80, 81** and **77, 78**. If either trim switch **53** or **54** is actuated up while trailer switch **52** is up, the diodes **63** and **64** render switches **53** and **54** prevents energizing of the relays **57** and **58**. However, if either trim switch **53** or **54** is actuated down while trailer switch **52** is up, the actuators **40** and **50** receive conflicting input signals and cease to operate the cylinder **30**.

Furthermore, actuation of trailer switch **52** down causes energization of both down terminals **45** and **45**A of the actuator systems **40** and **50**, respectively, to lower both drives **12** and **13** simultaneously. Simultaneous up operation of either trim switch **53** or **54** has no effect and down actuation merely duplicates the down signal on the actuators. Such downward movement of both drives will continue as long as trailer switch **52** is held down, even when the limit switches **55** and **56** close (and thereby cause the relay coils **57***b* and **58***b* to energize and open their contacts **57***a* and **58***a*, respectively,) because the circuits from stationary down contact **52***c* do not include the relay contacts.

With main switch **51** is closed and both drives are above the trim limit position of line **36** (FIG. **2**), then both limit switches **55** and **56** are open and both relays are off. In this situation, with trailer switch **52** off, up actuation of either or both trim switches **53** and **54** has no effect. However, down actuation of either (or both) trim switch **53** or **54** then will cause downward movement of both drives **12** and **13** simultaneously until the trim limit position is reached. More specifically, since the movable contacts **53***a* and **54***d* of the trim switches **53** and **54** are energized by means of the conductors **90** and **91**, closure of either movable contact **53***a* or **54***d* with its respective down contact **53***c* or **54***f* causes energization of other other down contact **53***c* or **54***f* through conductors **86** and **87** as long as relay coil **58***b* remains de-energized and its relay contact **58***a* remains closed. However, when either or both drives **12** and **13** descend to the trim limit line **36** (FIG. **2**) and either or both limit switches **55, 56** close, both relay coils **57***b* and **58***b* become energized and open their respective contacts **57***a* and **58***a*. When relay contact **58***a* opens, the circuit through conductors **86** and **87** between the trim switch contacts **53***c* and **54***f* opens. As a result, only that stationary down contact **53***c* or **54***f* which is in direct contact with its movable contact **53***a* or **54***d*, respectively, remains energized. Thus, the only down contact **45** or **45**A on the actuators **40** or **50**, respectively, which remains energized is that one associated with whichever contact **53***c* or **54***f* is energized.

Drives Below Trim Limit

As is apparent, assuming main switch **51** closed, whenever either or both drives **12** and **13** are within the trim range θ, either or both trim limit switches **55** and **56** are closed and, as a result both relay coils **57***b* and **58***b* are energized and both relay contacts **57***a* and **58***a* open. As a result, trailer switch **52** up has no effect, whereas trailer switch **52** down causes simultaneous downward tilt of both drives. Furthermore, either trim switch **53** or **54** down effects only corresponding down tilt of its corresponding drive **12** or **13**, respectively, as hereinbefore explained. In the latter case, for example, if movable contact **53***d* of port trim switch **53** is moved up and engages stationary up contact **53***e*, an electric circuit is established as follows: from battery terminal **71**, through switch **51**, through conductor **92**, through the closed trim limit switch **55**, through conductor **93**, through switch contacts **53***d* and **53***e*, and through conductor **81** to up terminal **44** of actuator system **40**. Diode **67** blocks energization of up terminal **44**A of actuator system **50**. Similarly, for example, if movable contact **54***a* of starboard trim switch **54** is moved up and engages stationary up contact **54***b*, an electric circuit is established as follows: from battery terminal **71**, through switch **51**, through conductor **92**, through the closed trim limit switch **56**, through conductor **94**, through switch contacts **54***a* and **54***b*, and through conductor **78** to up terminal **44**A of actuator system **50**. Diode **68** blocks energization of up terminal **44** of actuator system **40**.

The diodes **67** and **68** also prevent energization of up terminal **52***e* of trailer switch **52** from the trim switches **53** and **54**, respectively. Similarly, the diodes **65** and **66** prevent energization of the down terminal **52***c* of trailer switch **52** from the trim switches **53** and **54**, respectively.

I claim:

1. In combination:

a pair of drives mounted side-by-side on a watercraft, each drive being vertically movable in a trim range and in a tilt range;

mechanical means connected to said drives and permitting independent vertical movement of said drives within said trim range but preventing full independent vertical movement of said drives when either of said drives is outside of said trim range;

and control means for simultaneously moving both drives within said tilt range and for independently moving each drive within said trim range including

first means operable to move both drives down simultaneously regardless of the initial drive position and to move both drives up simultaneously only if both drives are initially in said tilt range;

and second means operable to move both drives down simultaneously only if both drives are initially in said tilt range and only until at least one drive reaches said trim range, and to move either drive individually up or down only if both drives are initially in said trim range and only until the drive being moved reaches said tilt range.

2. A combination according to claim 1 wherein said control means includes a selectively operable selector device to effect operation of said first means and wherein said control means includes a pair of selectively operable selector devices to effect operation of said second means.

3. In combination:

a pair of drives mounted side-by-side on a watercraft, each drive being vertically movable in a trim range and in a tilt range;

mechanical means connected to said drives and permitting independent vertical movement of said drives at least within said trim range but preventing full independent vertical movement of said drives when either of said drives is outside said trim range;

and control means for simultaneously moving both drives within said tilt range and for independently moving each drive within said trim range, said control means including selectively operable selector devices for effecting movement of said drives, said control means further including:

first means operable in response to actuation of one of said selector devices to move both drives down simultaneously regardless of the initial drive position and to move both drives up simultaneously only if both drives are initially in said tilt range;

and second means operable in response to actuation of another of said selector devices to move both drives down simultaneously and if both drives are initially in said tilt range and only until at least one drive reaches said trim range, and to move one drive individually up or down only if both drives are initially in said trim range and only until the drive being moved reaches said tilt range.

4. A combination according to claim 3 wherein said control means includes a selectively operable device to effect operation of said first means and wherein said control means includes a pair of selectively operable selector devices to effect operation of said second means.

5. A combination according to claim 4 wherein said control means includes electrical control means and wherein said selectively operable selector devices are electric switches.

6. A combination according to claim 3 wherein said mechanical means includes a tie-bar connected between said drives.

7. A combination according to claim 3 or 6 wherein said mechanical means further includes power steering cylinders connected to said drives.

8. In combination:

a pair of drives mounted side-by-side on a watercraft, each drive being vertically movable in a trim range and in a tilt range;

mechanical means connected to said drives and permitting independent vertical movement of said drives at least within said trim range but preventing full independent vertical movement of said drives when either of said drives is outside said trim range;

and control means for simultaneously moving both drives within said tilt range and for independently moving each drive within said trim range, said control means including selectively operable selector devices for effecting movement of said drives and means responsive to the position of said drives, said control means being operable in response to actuation of one of said selector devices and to said means responsive to the position of said drives to move both drives down simultaneously regardless of the initial drive position and to move both drives up simultaneously only if both drives are initially in said tilt range;

said control means being further operable in response to actuation of another of said selector drives and to said means responsive to the position of said drives to move both drives down simultaneously only if both drives are initially in said tilt range and only until at least one drive reaches said trim range, and to move one drive individually up or down only if both drives are initially in said trim range and only until the drive being moved reaches said tilt range.

9. A combination according to claim 8 wherein said control means includes three selectively operable switches, each switch being actuatable to an off, up and down position.

10. A combination according to claim 9 wherein said means responsive to the position of said drives includes a pair of limit switches, one for each drive unit.

11. A combination according to claim 8 wherein said control means further includes relay means controlled by said means responsive to the position of said drives to control the operation of said selectively operable switches.

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